**Lesson Plan Format**

**Teacher Candidate: Alexis Franklin Grade Level: 10 Date of lesson: November 2014**

**Content Standards:** State the unit goal and identify one or two primary local, state **or** national curricular standards to which your lesson aligns. What key knowledge and skills will students be able to demonstrate as a result of your instruction?

Standard:

10SS3: Students analyze political and economic change in the 16th, 17th, and 18th centuries.

10SS5: Students analyze the effects of the Industrial Revolution in England, France, Germany, Japan, and the United States.

10SS5.d: Summarize the massive social, economic, and cultural changes brought about by the industrial revolution.

CCSS.Math.Practice: Use tools strategically; Attend to precision; Look for and express regularity in repeated reasoning.

CCSS.Math.Content.HSA-SSE (Algebra): Write expressions in equivalent forms to solve problems. Use the properties of exponents to transform expressions for exponential functions.

CCSS.Math.Content.HSA-REI (Algebra): Understand solving equations as a process of reasoning and explain the reasoning. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

CCSS.Math.Content.HSA-REI.D: Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve.

CCSS.Math.Content.HSF-IF (Functions): Interpret, analyze, and graph functions.

CCSS.Math.Content.HSF-LE (Functions): Construct and compare linear, quadratic, and exponential models to solve problems. Distinguish between situations that can be modeled with linear functions and with exponential functions.

**Learner Background:** Describe the students’ prior knowledge or skill related to the learning objective(s) and the content of this lesson. How did the students’ previous performance in this content area or skill impact your planning for this lesson?

Students should already be familiar with the concept of a mathematical function and should be aware of some of the major types of functions—linear, quadratic, exponential, etc. Students should also be comfortable graphing functions by hand and/or with the help of technology. Students who will be determining the exponential function(s) themselves should know the basic rules of logarithms. And any students engaging the calculus extension should understand the concept of instantaneous rate of change and should be capable of finding the derivative of an exponential function. Additionally, most students will have background information/ideas about overpopulation in the real world.

**Student Learning Objective(s):** Identify specific and measurable learning objectives for this lesson.

Students will be able to explain the Malthus’ theory on population growth. Students will analyze perceptions of the earth’s carrying capacity. Students will evaluate whether or not overpopulation is a legitimate cause for concern in the modern world. Students effectively apply real-world data to an exponential growth equation so that they can evaluate Malthus’ theory and make connections to issues of scarcity in the real world.

**Assessment:** How will you ask students to demonstrate mastery of the student learning objective(s)? Attach a copy of any assessment materials you will use, along with assessment criteria.

Informal Formative: Students will participate in a variety of class discussions: Think-Pair-Share, small group, and full class.

Formal Formative: In small groups, students will generate concept maps about overpopulation.

Formal Formative: Students will place data on graphs and enter it into an exponential growth equation.

**Materials/Resources:** List the materials you will use in each learning activity including any technological resources.

* Youtube video “The Science of Overpopulation”
* Smartboard with graphing abilities
* Paper/pens for concept maps and math work
* Blank paper graphs for student work
* Class set of “World Population Milestones” data table
* Excerpt from “An Essay on the Principle of Population” by Thomas Malthus (1798)

**Teaching Model/Strategy**

Accurately names model/strategy; Explains **WHY** this model/strategy is chosen for these learners; Explains **how** model/strategy lends itself to learning this content, these skills and/or dispositions.

Interdisciplinary teaching on themes: This history lesson revolves around mathematical proficiency. Interdisciplinary education is important because it is a more authentic way of learning new information. It encourages a variety of connections that students might not otherwise make. Interdisciplinary lessons have more scaffolding potential to make learning more meaningful and enduring. It engages a greater diversity of students with distinct modalities and intelligences.

**Learning Activities:**

**Initiation:** Briefly describe how you will initiate the lesson. (Set expectations for learning; articulates to learners: what they will be doing and learning in this lesson, how they will demonstrate learning and why this is important)



Teacher will display historical artwork representing the agricultural economy of pre-industrial England. As a class, students will brainstorm ideas about what kind of society this was. How many kids did families probably have? How did families make a living? How long did people live? What kinds of things were necessary for survival in 1700’s Europe?

Teacher will explain that this was the context for famous philosopher and economist Thomas Malthus. Students independently read an excerpt from his essay on overpopulation, highlighting significant quotes. Teacher will instruct them to focus on Malthus’ prognosis for humankind, the specific problems he anticipated, and why he was making these claims. In small groups, students discuss the reading and their conclusions about Malthus’ claims. In a full class discussion, students relate this back to the artwork on the board, evaluating how Malthus’ historical perspective might have impacted his ideas about overpopulation.

**Lesson Development:** Describe how you will develop the lesson, what you will do to model or guide practice, what learning activities students will be engaged in order to gain the key knowledge and skills identified in the student learning objective(s). Identify the instructional grouping (whole class, small groups, pairs, individuals) you will use in each phase of instruction.

Teacher writes “linear” and “exponential” on the board, asking for students to define these two kinds of growth. According to Malthus, human populations grow exponentially, and the ability to feed human populations grows linearly. To help illustrate this, the teacher distributes the “World Population Milestones” table to students. Individually or in small groups, they will graph the data it contains. Students will Think-Pair-Share to contemplate the nature of the graph and recognize it as a possible example of an exponential growth curve. Teacher will then suggest to the students that the date could be represented/modeled by an exponential function of the form *A*(*t*) = *A*0*ekt*, with *A*0 representing the “initial” population amount, t representing the number of years after the initial measurement, and k representing the constant of growth. Actual function models and corresponding k values will vary according to the chosen *A*0 and other selected data points. For example, letting *t*=0 in 1930 and using 1999 as another point, the function is *A*(*t*) = 2*e*0.0159*t* (in billions). But other choices of initial values and second points will provide slightly different constants of growth. Teacher will lead brief class discussion about how choosing different variables affects the constants, demonstrating the data on the board.

Teacher will then introduce the concept of rates of change in the human population, still using the data from the “World Population Milestones” table. Students, again individually or in their same small groups, determine various average rates of change in population. For instance, the average rate of change in the human population between 1960 and 2010 was 3.8 billion in 50 years, or 76 million per year. Discuss whether or not such averages would represent an actual rate of change for a given year.

Students will then use their exponential function models to project human population values into the future. For example, again with the function from above, the population projection for the year 2020 would be *A*(90) or almost 8.4 billion. Students will consider the accuracy of such projections in light of any other factors that might affect growth rates. Tell them, for instance, that many demographers point to a current “slowing” in the growth rate (attributed largely to a decrease in the global fertility rate average) and that they do not expect the human population to reach the 8 billion mark until the year 2045 (Source: Kunzig 2011 National Geographic article).

In new small groups, students brainstorm the various impacts of the human population growth that they have been modeling. Each group will produce a concept map detailing the connections between human population increase and carrying-capacity issues such as food scarcity or urbanization. The kinds of issues they should come up with include deforestation, impacts of grazing, industrial-scale farming/fishing, ocean health, food/water supply, climate change forecasts, growth of megacities, poverty reduction, human migration, education (especially for girls/women) and family planning, energy requirements, cultural diversity and the rights of indigenous peoples, and comparative conditions in “developing” and “developed” regions.

After each group has had the opportunity to develop a concept map, the class comes back together as one group. Teacher facilitates a round-table discussion of some of the issues that came forward in the small groups and attempts to link the concept maps together into a single class concept map.

**Closure:** Briefly describe how you will close the lesson and help students understand the purpose of the lesson. (Interact with learners to elicit evidence of student understanding of purpose(s) for learning and mastery of objectives)

Students will watch a 10-minute Youtube video called “The Science of Overpopulation” (https://www.youtube.com/watch?v=dD-yN2G5BY0). This humorous video is a perfect review of the day’s lesson: starting with Malthus’ pre-industrial perspective, then developing the mathematical principles of exponential growth, and ending with an application to modern issues of scarcity. The graphs in the video resemble the graphs that students have generated, and many of the issues mentioned in the video will match students’ ideas in their concept maps.

**Individuals Needing Differentiated Instruction:** Describe 1 to 3 students with identified instructional needs. (These students may be special or general education students and need not be the same students for each lesson. Students may represent a range of ability and/or achievement levels.)

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| Student Name | 1. What is the student’s identified instructional need? 2. What evidence do you have that this is an instructional need? | Describe strategy for differentiating instruction **in this lesson** to meet this need. |
| Student 1 | Gifted/talented in mathematics | This student will not be given the exponential growth equation by the teacher, but will determine it herself using the data.  Optional calculus extension: Students familiar with derivatives, or instantaneous rates of change, could determine the derivative of their exponential function model and then evaluate that derivative for various years. For example, the derivative of the function mentioned above would be expressed as *A*′(*t*) = 0.0318*e*0.0159*t* and so the instantaneous rate of change in population for the year 2010 would be *A*′(80) or about 113 million people per year. Discuss the difference between such a rate and an average rate of change. Experienced calculus students could explore why and how a logistic function provides a more appropriate model for population than a basic exponential function, if the planet’s carrying capacity is more explicitly known or assumed. |
| Student 2 | Placed in a lower level math class than other students; lacks experience with functions | Can be strategically grouped with more knowledgeable, helpful peers. Student will receive extra explanation from teacher, particularly through graphing demonstrations on the Smartboard.  If student is sufficiently overwhelmed/confused by functions, they can be given an alternative assignment utilizing different math standards:  Student will use the annual growth rate determined by the class’ equation to demonstrate their ability to make conversions with large numbers. Student will convert annual growth rates (hundreds of millions of years) to weekly, daily, hourly, minute-by-minute, and second-by-second rates. Student will be able to contribute this “population clock” to the class discussion on exponential growth. |
| Student 3 | ELA student | Extra time spent addressing vocabulary, possibly even with vocabulary lists to distribute to interested students (includes history and math vocabulary terms). Essay can be read out loud as a class |